State of Ohio
tment of Highways and Public Works
Division of Highways

Instructions to Inspectors

To Guide Them in the Inspection of Material and Workmanship Used in the Construction of State Aid Roads

1922

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Bound at State Bindery.

INTRODUCTION

Careful and competent inspection is one of the most important elements entering into the construction of any improvement. Capable and efficient engineers may be employed, specifications and plans carefully prepared after the most thorough investigation and study of conditions, and the best material may be used, but without the proper combination of materials and careful workmanship at all times insured by continual, careful inspection, the work may fail. The idea of inspection is not to cause annoyance or arguments with the contractor, but it is to help him get the best results possible by watching careless employes and guard against faulty methods and the use of materials which would be detrimental to the work.

These instructions have been prepared with this in mind and it is hoped that they will stimulate that close co-operation between the contractor and the representatives of this Department, which is essential for the successful completion of the program in which we are all so vitally interested.

Our Department must have no alibis or excuses to offer when the road is completed.

E. C. Blosser,
State Highway Engineer.

DIVISION OF HIGHWAYS

COLUMBUS, OHIO

PURPOSE AND AUTHORITY

An inspector is placed on the work to keep the department informed as to the progress of the work and the manner in which it is being done; also to call to the attention of the contractor any infringements upon the plans or specifications. He is not authorized to approve or accept any portion of the work or to issue instructions contrary to the plans and specifications. The inspector must be on the road at all times while work is in progress and must give his constant personal attention to the duties of his position as herein specified.

He has the authority to reject defective material and to suspend any work that is being improperly performed, subject to the final decision of the Director of Highways and Public Works or his duly authorized assistant. The inspector is not authorized to revoke, alter, enlarge or relax the provisions of the specifications nor to delay the fulfillment of the contract by failure to inspect materials and work with reasonable promptness.

Conduct

The inspector must at all times be gentlemanly and business-like, but firm in securing honest work. He is the representative of the State on this particular work and should endeavor to make a favorable impression upon the public with whom he may come in contact. He must not discuss the work, the contractor or the Department with persons not connected with the same; he must not meddle in politics

while on the work and must confine himself strictly to the duties of his position.

Address

As soon as he is permanently established on the work the inspector must send to the Division Engineer his address and also the number of the telephone to which he has access.

Duties of the Inspectors

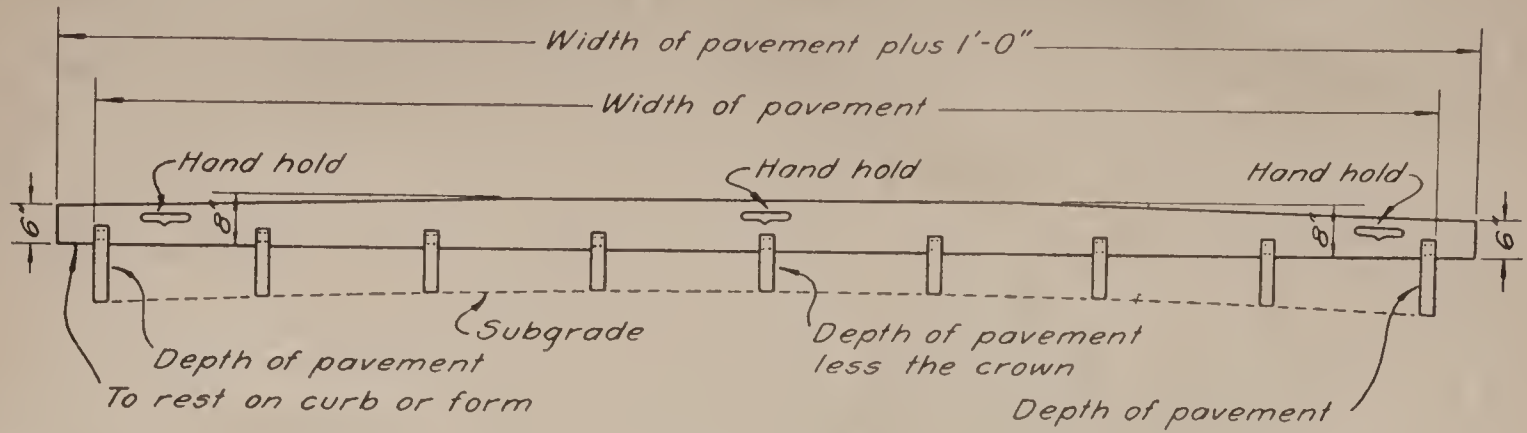
The duties of the inspector may be classified under three heads:

1st. The inspection of methods used in construction, including quality of workmanship. The specifications will furnish the necessary information for this work.

2nd. The inspection of both quantity and quality of material used. The inspector must assure himself that all materials have been sampled, tested and approved by the Department of Highways and Public Works before they are permitted to be placed in the permanent work. Instructions for selecting and shipping samples of materials are incorporated herein and should be followed absolutely.

3rd. The keeping of a daily record of the progress and condition of the work. The inspector will be furnished with a notebook in which he must keep a daily record of the progress and condition of the work. He must also note in this book each day events which will in any way have a bearing on possible future disputes, controversies or lawsuits. Weekly report blanks will be furnished which must be properly filled out and sent to the office of the Division Engineer within the Division and the State Highway Testing Laboratory at the end of each week and should reach them not later than the following Monday. In case the above-mentioned supplies are not sent, the inspector must make request for same without delay to the Division Engineer.

TEMPLET FOR TESTING GRADE AND CONTOUR OF SUBGRADE



Templet to be made of 1"x 8" White pine
Fingers to be made of 1"x 2" White pine
Fingers to be placed at edge of pavement,
on eighths on quarters and on center line.

4th. The inspector should have on the job at all times the following articles: —

(a) Set of Plans.
(b) Copy of Specifications.
(c) Copy of Instructions to Inspectors.
(d) Inspectors' Memorandum Book.
(e) 50 ft. steel tape.
(f) Templet for checking subgrade under his supervision.

Specifications

The inspector must thoroughly acquaint himself with the requirements of the plans and specifications for the work, and must keep a copy of the specifications with him at all times while work is in progress on the road. He should take particular care in studying the clauses found under the headings "General Provisions" and "Construction Details," as under these headings will be found detailed instructions for the proper performance of the work. There must be absolutely no change in the plans or specifications unless ordered in writing by the Division Engineer. If there is any point about the plans or specifications which he does not fully understand the inspector should make a note of the point and take it up with the Division Engineer at the first opportunity.

Relation of Inspector to the Resident Engineer

The resident engineer is the inspector's superior officer and his orders must be respected unless they conflict with the specifications. The inspector must keep in close touch with the resident engineer and assist him as much as possible in taking measurements, setting stakes, etc. Many of the stakes can be set by the inspector himself. He must see that the stakes are not lost or removed, and shall use care in preserving all stakes, reference points and bench marks. He must always insist upon a complete understanding of exactly

what the stakes represent, and see to it that the work is carried out in accordance therewith.

In the absence of the engineer the inspector is in full charge of the work and is there to see that the specifications are rigidly carried out. All of his orders in accord with the plans and specifications must be obeyed; if they are not, his duty is to stop the work on that branch in dispute and communicate with the resident engineer at once.

Suggestions for Daily Routine

1st. Check cars received at unloading station.

2nd. Record all labor operations and men employed.

3rd. See that all equipment and materials are ready for the day's operation.

4th. See that subgrade is in proper condition for the pavement and check with the Templet.

5th. See that sufficient grade stakes are set ahead for the grading and pavement.

6th. Check alignment of forms.

7th. Examine material arriving on the job.

8th. Be sure that all materials received are in accordance with the specifications. Necessary samples should be taken as per instructions and forwarded to the Department.

9th. Check alignment and grade of finished pavement.

10th. Check up work being done on culvert and bridges in advance of the pavement.

11th. Measure total pavement constructed during the day and check materials used.

12th. Make entry of day's operation and record all data necessary for weekly reports.

13th. Before leaving the job at night, the inspector should see that proper precautions are taken to protect all

work performed and that all necessary barricades and lights are in place.

14th. Before retiring each night review the specifications and pay special attention to the articles covering the work in hand.

Dont's

DON'T, under any circumstances, make any agreement with the contract or for the furnishing of material, teams, or labor, nor derive any profit from anything used in the construction of the road.

DON'T quarrel with the contractor or foreman. If possible keep on good terms with them, but at all times be firm in holding them to the terms of the contract.

DON'T give orders to workmen. If work is not being done properly notify the foreman or person in charge of the work.

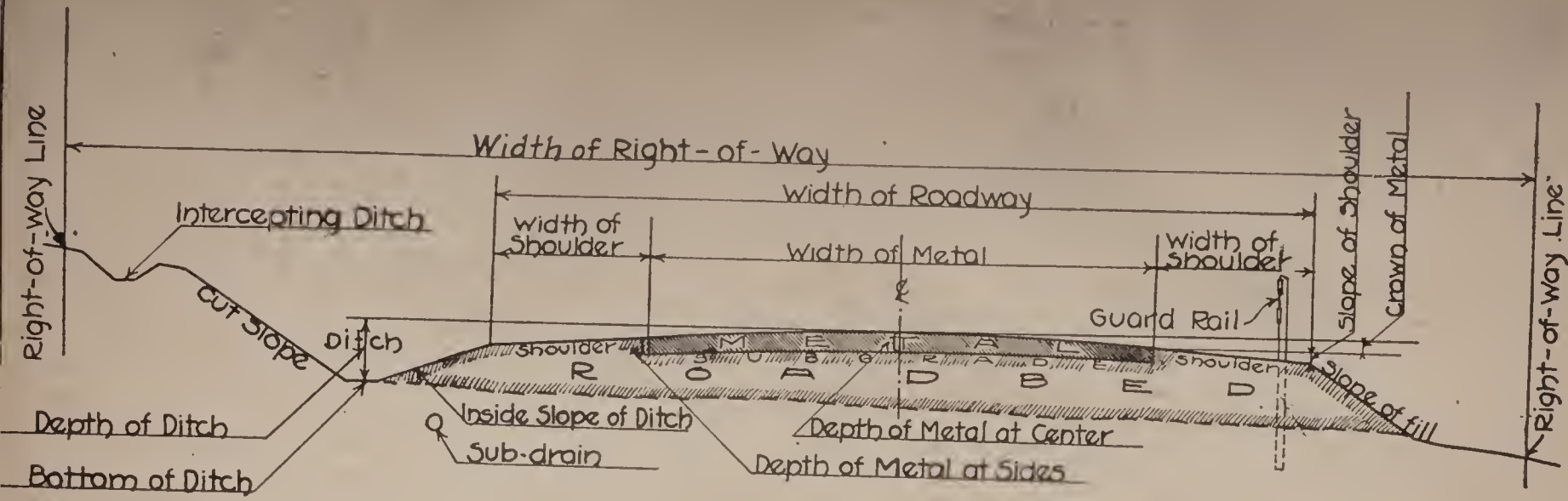
DON'T do work on the road. You are paid to see that the work is done properly, not to do it yourself.

DON'T accept favors from the contractor or try to be a "good fellow."

DON'T be intimated or "bluffed" by the contractor or any of his employees, and report any or all threats, if any be made.

DON'T take orders or follow out suggestions from the contractor or from outside parties concerning the manner of doing work. Complaints and suggestions by residents along the road may be considered and reported, but orders must be followed as given by the Department, and plans and specifications carried out, unless written consent to a change is secured from the Department.

DON'T let the contractor deposit stone or other material within the lines of the road at any point until the grading and rolling has been properly completed.



CROSS-SECTION

SHOWING

CONVENTIONAL TERMS

AS APPLIED TO

HIGHWAYS

STATE HIGHWAY DEPARTMENT

COLUMBUS, OHIO

815

Cross-section of road showing meaning of various terms applicable thereto.

WATERBOUND MACADAM

A macadam pavement is constructed of broken stones bound together with stone screenings. When water is used to assist in the binding, the pavement is known as waterbound macadam.

The specifications as to the treatment of macadam are to be your guide at all times, but it is the purpose of this paragraph to emphasize and enlarge upon a few particular points. In the construction of a macadam road the points to be observed are:

1. The thorough consolidation and specified crown of the subgrade or earth bed.

2. Cleanliness of the stone; it must be free from clay and loam. This is especially necessary for screenings.

3. Size of the stone as given in the specifications. Long, flaky pieces or "tailings" must be excluded or broken; they will never compact, no matter how much they are rolled.

4. An excessive quantity of binder must not be used. The proportion should be about equal to the voids in the broken stones. By using a larger quantity than this the amount of rolling is lessened, but at the expense of durability.

MACADAM. The pieces of stone should be as nearly cubical as possible and be clean and free from dust, dirt and screenings, for the reason that is impossible to prevent the dust and screenings from being deposited in bunches and producing weak places in the road. All excess of dust and screenings on the finished road is to be avoided as it ruts easily and produces a soft surface. The watering of the finishing layer shall be thorough and the watering and rolling continued until water flushes over the whole surface and the passage of the roller will bring moisture to the partially dry

Showing the method of filling a water-bound macadam with screenings. The men turn the shovel so as to spread the screenings thinly over the surface, thus slowly feeding them into the voids as the rolling progresses. In this manner, all the voids are filled and a *dense uniform* surface produced.

surface, as in the case of concrete when it is tamped. If the material sticks to the roller it is clear evidence that there is not sufficient water being used.

The roller operator must not be permitted to dump cinders or ashes upon the macadam at any stage of the work. Should any cinders appear among the stone the contractor will be required to rake back the stone and remove the cinders before screenings are applied.

No screenings shall be dumped on either layer, but they should be deposited in piles on the shoulder or at one side of the road. The materials should be evenly applied to the road with a spreading motion of the shovel, as the rolling progresses. The inspector must go over the work as the rolling progresses and direct the spreading of sceenings in places where voids apper. It is also desirable that there shall be no displacement of the rolled stone before the spreading of the screenings, but should this occur the roller shall be brought into use again immediately before the spreading of screenings has begun. The calks of horse shoes and wheels of vehicles driven over the surface of the rolled stone will tend to loosen and displace the stone, leaving pockets that will be filled with screenings, making weak spots in the road. The intention of the specifications is that the stone shall be closely packed together and held in place until the interstices have been completely filled with screenings. The rolling on each course should be continued until the stones are brought firmly together and do not move ahead of the roller, or when walked over. Any hollows or depressions in either layer that develop during the process of rolling shall be filled with the same size of stone that has been used in the layer and brought to a true grade when rerolled. The stone in the depression must be loosened before new stone is added.

Heavy loads of material will not be permitted on the surface of an unfinished road, nor after the finishing until the road has completely dried.

Grouting Water-bound Macadam.

The inspector must not permit material of any kind to be placed upon the subgrade when it is in a soft or muddy condition, or when the ground is full of frost. He must see that trenches are cut that will thoroughly drain the subgrade during wet weather, and while construction is under way. After the road has been completed there will be no necessity for subdrainage, as the finished surface will act as a roof, completely shedding water from subgrade. The inspector must keep a record of the depth of the stone in each course of each 100-foot station, after the stone has been rolled, but before screenings have been applied.

BITUMINOUS MACADAM

When a bituminous cement is used to hold the stone of a macadam pavement in place and make the pavement water-tight, the pavement is known as bituminous macadam.

Tar or asphalt binders should be applied only in warm, dry weather. The conditions which should be particularly observed by the inspector are as follows:

1. The stone for the upper course should be clean and free from dust at the time of applying the binder. If the stone should be coated with dust or other fine material, the binder would not penetrate and would soon peel off, resulting in a raveling of the surface.

2. The stone should be dry. Moisture will prevent the proper adhesion of the binder.

3. The binder should be applied during warm weather. Cold weather has a tendency to chill and stiffen the binder before it has time to penetrate, and unsatisfactory work will result. The inspector should observe and record the temperature of the binder in the tank from which the application is being made as well as the temperature of the air at the time the work is being lone.

The inspector should keep an exact record of the number of barrels of tar or asphalt binder that is used on each one-hundred-foot section of roadway, so that it may be ascertained whether the contractor is using the specified amount of material per square yard of surface.

4. In no case shall the inspector allow bituminous material to be applied until he has received a favorable report on the samples submitted.

Applying bituminous material with a pressure distributor mounted on a truck. A fine spray of bituminous material thrown against the road surface with considerable pressure brings the material into intimate contact with the stone surface, thus assuring a bond thereto.

BRICK ROAD

In the work on a brick road, the specifications furnish information and directions for the greater part of the work, but circumstances and conditions usually arise when the inspector must be guided by his own judgment and discretion.

Curb

The inspector must see:

1. That the forms are accurately and securely lined and braced.

2. That the inner surfaces of the forms are thoroughly drenched before concrete is put in place.

3. That the surface of the concrete is worked smooth by spading and troweling.

4. That the forms are left in place and the exposed surface of the concrete kept wet until it has thoroughly set. Care should be used in removing the forms so as not to injure the concrete.

Foundation

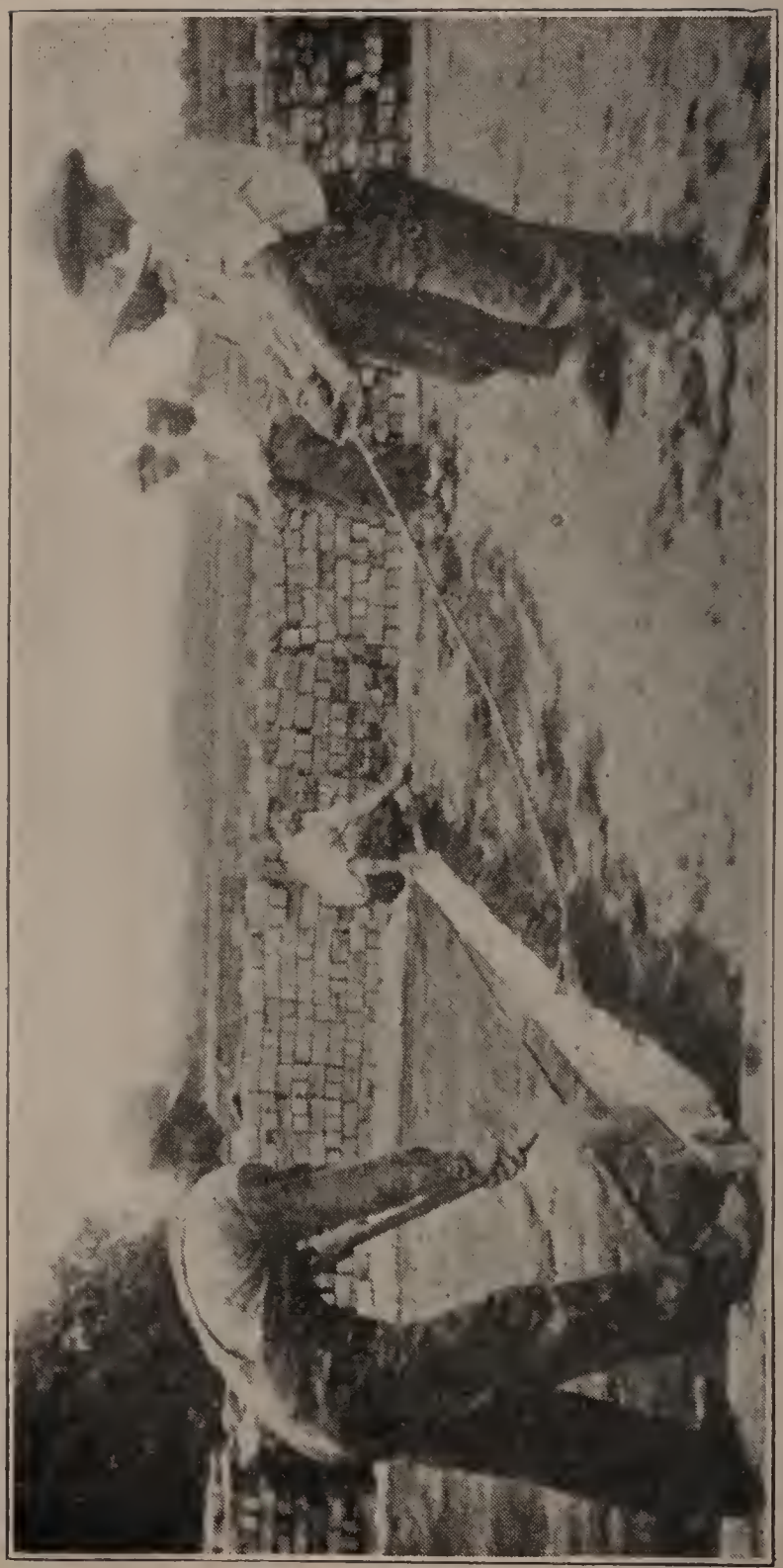
The inspector must see:

1. That the subgrade is thoroughly rolled and compacted, and has the specified crown.

2. That the foundation material is equal to the samples submitted and has the required depth and crown, and is well rolled.

3. Where concrete foundation is used, he shall insist on all of the details of the specifications being followed.

4. That the sand used for the cushion coat is of good quality, dry and properly luted and rolled before brick are



Showing Method of Leveling Sand Cushion.

laid. It is impossible to make an even and uniform cushion coat out of wet sand. The surface of this sand cushion or bed should have the specified crown as shown by cross-section drawing. The cushion coat should have a uniform depth, must be of fine sand and must not contain any pebbles larger than one-half inch in greatest dimensions.

Laying

The importance of care in proper laying the brick can hardly be overestimated. After laying no loads should be permitted on the brick during the process of construction. The inspector should see that the lines of brick are kept straight and the specifications rigidly carried out in every detail. If lug brick are used, see that lugs all face in same direction.

Rolling

The brick must be thoroughly rolled before filling, as it is impossible to get a smooth and uniform surface without exercising great care in this particular.

Culling

After the brick are laid and before rolling, the inspector shall carefully examine the same. The brick to be removed should be marked with an X and those to be turned with an I. This marking may be done with lumber crayon or chalk. It is not a duty of the inspector to turn brick or remove faulty ones. The inspector should see that the contractor removes all culled brick from the work and that they are replaced by brick of acceptable quality before the work of rolling and filling is undertaken.

Grout Filler

See that the proper proportion of sand and cement is used. The sand must be fine or it will fail to go down be-

Rolling Sand Cushion for Brick Pavement.

Showing Laying of Brick for Brick Pavement.

tween the bricks. It must also be dry, and it shall be thoroughly mixed with the cement, until the mass assumes a uniform color without streaks, before the water is added. It must be mixed in small quantities, as it is almost impossible to keep the sand in suspension in quantities larger than those specified. Unless it is perfectly mixed when it is deposited on the pavement the water and cement will go to the lower portion of the joints between the bricks and the sand will remain on top. In mixing the grout it is best to add the water slowly, making a mortar first and continue adding water until the required consistency is attained. The first pouring must be almost as thin as water. The second pouring must be about like thick cream. Experience is required to know when you are getting the best results and you are advised to study this work very carefully until you have determined the exact conditions that are most desirable. The pavement must be thoroughly saturated with water before beginning the pouring. This is the most particular work in the laying of a brick pavement, and the success of the pavement depends more on proper filling than any other one thing that enters into the construction except brick.

Particular care must be exercised in covering the pavement within 15 minutes after the cement grout filler is placed. It must be sprinkled and kept damp for several days in order to prevent the grout from drying out before it has properly set.

Bituminous Filler

Where bituminous filler is used the inspector should be sure that the brick are thoroughly dry, as damp or wet brick defeat the object of the bituminous filler. He should be absolutely sure that the joints are completely filled to the top and he should keep an accurate record of the number of gallons used over a known area.

Showing operation of filling brick pavement with bituminous filler (not tar mastic).

Showing operation of filling brick pavement with tar mastic filler. The Squeegee method is used.

Monolithic Brick

The specifications for monolithic brick pavement cover the subject thoroughly and no deviation therefrom should be made without the consent of the Division Engineer.

Applying cement grout filler to the brick pavement.

CONCRETE PAVEMENT

The construction of a concrete pavement requires the constant personal attention of the inspector. He must know from personal observation that every batch of concrete placed in the pavement contains the proper amounts of coarse and fine aggregates, cement and water.

The following must be carefully observed:

1. That the cement used has been tested and approved.

The inspector must send a sample of cement from every carload shipment to the laboratory for testing, and no cement shall be allowed to go into the concrete pavement that has not passed the 7-day test.

Very frequently the cement is reserved at the warehouse for the contractor in order that samples may be taken and tests made before the cement is shipped. Such cement should be marked when sampled so that it can be identified when it comes on the job. It is a good plan to sample this cement as it comes to the work and have check tests made.

Cement that has been stored over winter or through a wet period must be regarded with suspicion and carefully tested before using.

2. That the stone or gravel and sand have been tested and approved. When the proper selection of these materials has been made, the inspector must see that the standard of quality is conscientiously kept up.

3. That the side forms and templets are kept clean and of true form. There should be a templet for the subgrade and a templet for the surface of the pavement.

The inspector should keep all measurements for laying out the templets in his record book so that he can check up the templets at any time.

4. That the subgrade is in true shape and well compacted before any material is hauled onto it, and that it is maintained in such shape until concrete is placed.

5. That the expansion joints are placed in an absolutely vertical position. The inspector must carefully examine each joint as it is finished and if it is found not vertical must be removed at once and replaced by another at a point as close to required location as possible.

6. That the concrete is of the proper consistency and special reference to this will be found under the Heading of Field Tests on page 43 of these instructions.

7. That the necessary test cylinders are made and shipped according to instructions on page 45.

8. That the concrete is properly protected and kept wet for the period required under the specifications.

BITUMINOUS CONCRETE ROAD

In the construction of a bituminous concrete pavement all requirements for curb and foundation are the same as given under brick road.

The determination of the proper mix in the bituminous concrete is left to the testing engineer. The inspector must notify the Resident Engineer in ample time to allow of such determination. The closest inspection is required in the preparation of the mixture when same is being placed on the road.

Special attention is called to inspectors on Instructions to Road Inspectors on page 66 of these Instructions and should be strictly adhered to.

INSTRUCTIONS FOR COLLECTING AND FORWARDING SAMPLES OF MATERIALS

General Instructions

1. The most important point to be observed in the selection of samples of materials is to obtain a small quantity or sample which is actually representative of the larger lot from which it is taken.

Where the nature of the material permits, make a careful examination of the entire lot in order to determine its general character and the variation between different portions. Then select the sample in such a manner that it will represent all the different grades in the same proportions as they occur in the larger lot.

2. After samples are taken (cement, bituminous materials, etc.) care should be taken to prevent exposure to air, moisture, dirt, or any foreign material. See that all containers are clean before placing samples therein. This is especially important with reference to cans for submitting samples of tars, asphalts, oils, etc. Such containers after filling must be tightly sealed, preferably with solder, and *thoroughly cleaned* on the outside before being wrapped for shipment. Samples of concrete sand must never be shipped in unwashed sugar sacks as even a very small per cent. of sugar may so effect the sand as to make the test worthless.

3. Samples of materials proposed to be used in bridge construction are to be considered of equal importance with those to be used in pavement construction.

4. Extreme care must be taken in the sampling and inspection of materials, and the inspector must not permit the contractor to use any construction materials until advised that they are acceptable. The inspector shall require that

rejected materials be removed from the work and not returned.

5. The inspector must arrange to receive sufficient notice from the contractor of car arrivals, so that materials can be propely inspected before unloading and without loss of time to the contractor.

6. All samples weighing less than twenty-five (25) pounds should be sent by parcel post prepaid. This method of delivery is usually more prompt than express. Samples of brick, stone, and gravel should be sent by express. In no case send samples by freight.

7. Extreme care, particularly with reference to parcel post shipments should be taken in packing samples to avoid breakage or leakage of materials in transit at the risk of destroying other valuable mail. All liquid materials should be properly marked on outside of package: — LIQUID — FRAGILE — to conform with Postal Regulations.

8. **By all means see that a card giving complete data with reference to the sample is enclosed with each and every sample submitted to the testing laboratory.**

9. **Send all samples promptly to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus, Ohio.**

10. Samples are to be taken by the Engineer or his authorized representative.

11. The inspector shall keep a record of all materials delivered on the job, all samples submitted, etc., as indicated on the Inspector's Weekly Report Blank. A copy of the Weekly Report must be sent to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus, Ohio, each week, as well as to the office of the Division Engineer.

Stone

1. **When Taken:** Samples are to be taken from the proposed source of supply at least 7 days before the stone is to be accepted or rejected, also unless otherwise directed, from every 2,000 cubic yards quarried or delivered, or when the quality or appearance of the stone changes, and at such other times as may be directed by the engineer.

2. **Where and How Taken:**

(a) *Sampling for quality.* Samples should be taken either from the quarry or from cars as directed by the engineer, and shall be sound interior rock representative of that which it is poposed to use.

(b) *Sampling for size.* Samples of the crusher product shall be taken either at the crusher or from cars as directed by the engineer. The samples shall be mixed from runs of the crusher, on different days, or, if taken from cars, shall be taken from both ends and top and bottom of the car.

3. **Amount and Size of Sample:**

(a) *Sampling for quality.* A sample shall weigh between twenty-five (25) and forty (40) pounds, and shall consist of pieces of rock at least one and one-half (1½) inches in size. and one piece at least three by four by four (3 by 4 by 4) inches, free from seams and cracks.

(b) *Sampling for size.* A sample for size shall weigh not less than ten (10) pounds for materials of three-quarters (¾) inch maximum diameter or less. Samples of materials of other sizes shall increase in weight to a maximum of approximately sixty (60) pounds varying with the size and weight of the largest pieces represented by the sample. The sample shall be representative of the product as delivered for use.

Marking and Shipping: Samples shall be shipped in tight boxes or bags and shall be accompanied by a card (TL-14), in the container or securely attached thereto, stating date, county, I. C. H. No., Section letter, by whom sub-

mitted, owner, location of quarry or source of supply, exact location where sample was taken, proposed purpose to which the material is to be put, and in case of quarry investigations, quantity available, amount and character of stripping, whether material from same source has been previously used, where and for what purpose, and with what results, haul to nearest point on road, average haul to job, character of haul, initial cost of rock. Sample should be sent by express to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus. Ohio.

Notification of sampling (card TL-14), containing the above data, shall also be forwarded separately to the laboratory immediately upon taking the sample.

Gravel

1. **When Taken:** Samples are to be taken from the proposed source of supply at least 7 days before the gravel is to be accepted or rejected, also from every 1,000 cubic yards, excavated or delivered, or when the quality or appearance of gravel changes, and at such othe times as may be directed by the engineer.

2. **Where and How Taken:**

(a) *Sampling at the pit.* Enough sample shall be taken to represent an average of the material. An individual sample must be taken through a full vertical section of that material which it is proposed to use at the point selected. Each sample shall be taken from a freshly exposed vertical face.

(b) *Sampling from cars.* Enough samples shall be taken, as directed by the engineer to represent average composition. Samples from cars shall be taken from both ends and from top and bottom of the car.

3. **Amount and Size of Sample:**

(a) *Sampling for quality.* Samples shall weigh —

For screened gravel, 25 to 30 pounds.

For bank gravel, 50 to 75 pounds.

(b) *Sampling for size.* A sample for size shall weigh not less than ten (10) pounds for material of three-qaurters ($\frac{3}{4}$) inch maximum diameter or less. Samples of materials of other sizes shall increase in weight to a maximum of approximately sixty (60) pounds, varying with the size and weight of the largest pieces represented by the sample. The sample shall be representative of the product as delivered for use.

4. **Marking and Shipping:** Samples shall be shipped in tight boxes or bags and shall be accompanied by a card (TL-14) in the container or securely attached thereto, stating date, county, I. C. H. No., section letter, by whom submitted, owner, location of deposit or source of supply, exact location where sample was taken, proposed purpose to which the material is to be put, and in case of pit or bank investigation, quantity available, amount and character of stripping, whether material from same source has been previously used, where and for what purpose, and with what results, haul to nearest point on road, average haul to job, character of haul, initial cost of gravel. Samples should be sent by express to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus, Ohio.

Notification of sampling (card TL-14), containing the above data, shall be forwarded separately to the laboratory immediately upon taking of the sample.

Sand

1. **When Taken:** Samples are to be taken from the proposed source of supply at least 10 days before the sand is to be accepted or rejected, also from every 500 cubic yards excavated, or delivered or when the quality or appearance of

the sand changes, and at such other times as may be directed by the engineer.

2. **Where and How Taken:**

(a) *Sampling at the pit.* Samples shall be taken from freshly exposed portions of the deposit as directed by the engineer. Mixed samples may be taken if deemed necessary.

In general, the number of samples shall be sufficient to cover the extreme variation of quality in that part of the deposit which is proposed to be used.

(b) *Sampling from cars.* Enough samples shall be taken, as directed by the engineer, to represent average composition. Samples from cars shall be taken from both ends and from top and bottom of the car.

3. **Amount and Size of Sample:** Each sample, whether individual or composite, shall weigh between ten (10) and fifteen (15) pounds.

4. **Marking and Shipping:** Samples shall be shipped in tight boxes or bags and shall be accompanied by a card (TL-14) in the container, or securely attached thereto, stating date, county, I. C. H. No., section letter, by whom submitted, owner, location of deposit or source of supply, exact location where sample was taken, proposed purpose to which the material is to be put, and in case of source investigation, quantity available, amount previously used, where and for what purpose, and with what results, haul to nearest point on road, average haul to job, character of haul, initial cost of sand. Sample should be sent by Parcel Post to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus, Ohio.

Notification of sampling (card TL-14) containing the above data, shall also be forwaded separately to the laboratory immediately upon taking of the sample.

Cement

1. **When Taken:** Unless otherwise ordered, samples are to be taken from each car of cement delivered at least 10 days before the cement is to be accepted or rejected.

2. **Where and How Taken:**

Composit Sample. — If sampled in cars one sample shall be taken from one sack in each 40 sacks (or one barrel in each 10 barrels) and combined to form one test sample. If sampled in bins or warehouses one test sample shall represent not more than 200 barrels.

Cement may be sampled at the mill by any of the following methods that may be practicable, as ordered:

(a) *From the Conveyor Delivering to the Bin.* — At least five (5) pounds of cement shall be taken from approximately each 100 barrels passing over the conveyor.

(b) *From Filled Bins by Means of Proper Sampling Tubes.* — Tubes inserted vertically may be used for sampling cement to a maximum depth of 10 feet. Tubes inserted horizontally may be used where the construction of the bin permits. Samples shall be taken from points well distributed over the face of the bin.

(c) *From Filled Bins at Points of Discharge.* — Sufficient cement shall be drawn from the discharge openings to obtain samples representative of the cement contained in the bin, as determined by the appearance at the discharge openings of indicators placed on the surface of the cement directly above these openings before drawing of the cement is started.

3. **Amount and Size of Sample:** Each test sample should consist of not less than three (3) pounds.

4. **Marking and Shipping:** Samples shall be placed in tight boxes, tin buckets, or canvas sacks furnished by the Department, and shall be accompanied by a card (TL-12) in the container, or securely attached thereto, stating date, county, I. C. H. No., section letter, by whom submitted,

sample number, car number and number of barrels represented. Samples should be sent by Parcel Post to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus, Ohio.

Notification of sampling (card TL-12), containing the above data, shall also be forwarded separately to the laboratory immediately upon taking of the samples.

Paving Brick

1. **When Taken:** Samples are to be taken at least four days before the brick are to be accepted or rejected. Unless otherwise ordered by the engineer, at least one set of samples should be taken for every 100,000 brick delivered. If at any time a shipment of brick is received, in which the quality of the brick does not appear equal to that of samples previously submitted, additional samples should be immediately sent to the Testing Laboratory.

2. **Where and How Taken:**

Samples at point of delivery. — If all the brick in a shipment or several shipments of the same make and kind of brick appear to be uniform in quality, two samples of twelve each may suffice. If in a shipment there appears to be different classes of brick, such as brick that appear to be more or less burned than others, a representative lot of twelve brick is to be secured for each class of brick, exclusive of the culls.

Sampling from piles. — In general, samples selected from piles shall be as nearly as possible representative of the entire run of bricks. Samples from piles shall be taken from as many different points corresponding to the length, breadth and depth of the pile as possible. In no case shall they be confined to the upper or outer few layers. When controversy arises regarding the admissibility of certain types or portions of the lot, entire test samples may be selected from such types or portions having characteristic appearance in common.

Plant Inspection — For detail instruction covering sampling and testing brick at plant see "Instructions to Plant Inspectors at Paving Brick Plants."

3. **Amount and Size of Sample:** The number of brick required for a standard rattler test is ten. However, it is generally advisable to include two extra for each test to allow for breakage in transit.

4. **Marking and Shipping:** Samples shall be shipped in boxes or crates containing twelve brick each and shall be accompanied by a card (TL-11) in the container or securely attached thereto stating date, county, I. C. H. No., section letter, by whom submitted, brand, name of manufacturer, sample number, type or quality of brick and number of brick represented. Samples should be sent by express to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus, Ohio.

Notification of sampling (card TL-11) containing the above data, shall also be forwarded separately to the laboratory immediately upon taking of the sample.

Bituminous Materials

Caution. See that all sample cans are tightly sealed. Lids should be soldered in at least three places.

General Recommendation. All samples shall be selected to represent as nearly as possible an average of the material, care being taken that they are not contaminated with other materials. All samples must be sent in *perfectly clean tin* cans.

In collecting samples, if there is any doubt of the homogeneity of the material, individual samples should be taken as hereinafter described and such samples should be forwarded to the laboratory where tests will be conducted to determine the uniformity after which a composite sample of equal parts of the individual sample may be mixed for complete tests.

1. **When Taken:** Unless otherwise ordered samples are to be taken from every car of material delivered, at least four days before bituminous material is to be accepted or rejected.

2. **Where and How Taken:**

Semi-solid Products. Materials in barrels or drums should be sampled by taking samples from not less than 5 per cent of the containers.

Whenever possible the portion of the sample from each drum or barrel should be taken from near the heart of the barrel after it has been split open. Where samples must be taken from the top of the barrel, the material lying within three (3) inches of the surface should not be included. A hatchet or any sharp pointed tool is suitable for the purpose of digging into the barrel. (*Caution* — Do not use kerosene on the blade.) The several portions are then to be pressed in a can of approximately one-quart capacity, using enough material very nearly to fill the can which is then tightly covered.

Tank car shipments are to be sampled through the dome by the use of a clean hot shovel or other suitable tool.

Fluid Products. — When a fluid material is shipped in tank cars and the sample is to be taken directly from the tank car to represent an average of the entire tank car contents, one of the following methods is suggested:

(a) A tin can with a tight removable cover and a wire handle is secured, and a number of holes one-eighth of an inch in diameter are punched in the cover. This bucket is then weighted in any convenient way and lowered slowly by means of a cord attached to the handle through the entire depth of the tank car, so that the can will be filled with material from all depths of the car. This can is then emptied into another can of at least one-quart capacity having a screw top or other equally tight cap or cover.

(b) The sample may be taken by lowering a weighted bottle or can into the material. The bottle or can should be

fitted with a stopper which can be removed by a string or wire attached to it after it has been lowered to the proper depth. Samples should be taken from near the top, middle and bottom of the tank. Unless it is evident that pronounced variation exists in the different samples they are to be mixed and placed in a *clean quart tin* can for shipment.

A sample is more representative when the tank car has been agitated before the sample is taken.

Where individual samples are desired to check the uniformity of material throughout a tank car it is suggested that "thief samples" be taken from top and middle and a third sample be taken from the outlet valve through which a sufficient amount of bituminous material has been allowed to flow in order to clean the valve properly.

3. **Amount and Size of Sample:**

Each sample of asphaltic oil whether individual or composite shall be not less than 1½ pints and not more than one quart. For asphalt cements and tar products a sample of one pint is sufficient.

4. **Marking and Shipping:** Samples shall be shipped in *tightly sealed, clean tin cans. Under no circumstances use glass cans for submitting samples of bituminous materials.* Each sample shall be accompanied by a card (TL-13) in the container or securely attached thereto, stating date, county, I. C. H. No., section letter, by whom submitted, brand, name of manufacturer, sample number, car number, number of barrels represented, and proposed purpose to which the material is to be put. Samples should be sent by Parcel Post to the State Highway Testing Laboratory, Brown Hall, O. S. U., Columbus, Ohio.

Notification of sampling (card TL-13) containing the above data shall also be forwarded separately to the laboratory immediately upon taking of the sample.

FIELD TESTS

METHOD OF TEST FOR CONSISTENCY OF CONCRETE

The consistency of concrete is very important because the strength is greatly reduced by the use of excess water. With the "sloppy" concrete sometimes used in pavement and building construction, two-thirds to three-fourths of the possible strength of the concrete may be lost, due entirely to an excess of mixing water.

Scope: This test covers the method to be used, both in the laboratory and in the field, for determining the consistency of concrete.

Apparatus: The test specimen shall be formed in a mold of 16 gage galvanized metal, in the form of the lateral surface of the frustum of a cone with the base 8 inches in diameter, the upper surface 4 inches in diameter, and the altitude 12 inches.

Sample: When the test is made at the mixer, the sample shall be taken from the pile of concrete after the entire batch has been discharged. When testing concrete that has been hauled from a central mixing plant, the sample shall be taken from the concrete after it has been dumped on the subgrade.

Procedure: The mold shall be placed on a flat, non-absorbent surface, such as a smooth plank or a slab of concrete, and the operator shall hold the form firmly in place, while it is being filled, by standing on the foot pieces. The mold shall be filled to about one-fourth of its height with the concrete, which shall then be puddled by 20 to 30 strokes with a half inch rod pointed at the lower end. The filling shall

Showing Improper and Proper Consistency of Concrete by Truncated Cond Test.

be completed in successive layers similar to the first and the top struck off so that the mold is exactly filled. The mold shall then be removed by being raised vertically, and at exactly three minutes after being filled. The molded concrete shall then be allowed to subside until quiescent and the height of the speciment measured.

Slump: The consistency shall be recorded in terms of inches of subsidence of the specimen during the test, which shall be known as the *"slump."*

Slump = 12 minus (inches of height after subsidence.)

NOTE — This test is not considered applicable where there is a considerable per cent of aggregate above 2 inches in size.

Directions for Making Concrete Test Cylinders

Equipment — The inspector should be provided with the following equipment: (a) Paraffined paper molds, measuring 12″ x 6″ when stapled together, (b) a small shovel, (c) a ½″ iron rod approximately 18″ long, (d) trowel, (e) two boards, smooth surfaced, approximately 2′ square.

Sampling Intervals — For every 1,500 lineal feet of concrete placed or as may be directed, two 12″ x 6″ specimens should be prepared as hereinafter described. When the specimens are made the inspector should make note of the exact station at which samples were taken.

Preparation of Specimens — The concrete should be selected from *one batch* and be representative of the average mix. Sufficient concrete (about six shovels) to mold the specimens should be collected with a shovel from different parts of the pile of concrete as dumped from the mixer. This is placed on one of the boards, the molds having been previously placed on the other board. The concrete should be placed in each mold, by means of a shovel or large trowel, in four layers, the operation to be continuous, at the same time the one-half (½) inch iron rod should be used to puddle

the concrete lightly in order to displace all air and to distribute the aggregates uniformly throughout. Care should be taken not to puddle to excess as this results in bringing excess grout to the top and segregates the course aggregate. After the cylinder has been filled with concrete and before the top surface has been smoothed, the inspector should rotate the mold through a half circumference pressing the mold firmly downward, so that the ends of the mold rest flat on the board at all times. This will insure that both top and bottom of the specimens are parallel, and also perpendicular to the sides; this manipulation is extremely important as proper results are not secured unless the concrete conforms to the form of the mold. All specimens are to be molded in one continuous operation. Do not partially fill them at one time and finish them at another.

Curing — Specimens should be kept under a dampened cloth for a *one* day period, then buried flat under moist earth for two days.

Shipping — On the *fourth* day after molding the specimens should be carefully packed in a wooden box, partitioning the specimens from one another and the box by means of sand or paper. Sample identification tag form TL-26, properly filled out, *must* accompany each and every specimen submitted. This must include the following information — County, inter-county highway number, section letter, station or location, proportions, brand, kind or source of materials used. "Slump" or Consistency — *A duplicate identification tag should be sent to the Testing Laboratory by mail.*

In general, Laboratory tests will be made on specimens at the age of 7 days and 28 days, therefore, they should be forwarded promptly from the work at the end of the four day period.

If after the work has progressed satisfactorily for two weeks and, providing the specimens tested at the age of 7

days show the concrete to be of good quality and running reasonably uniform in strength, the number of specimens may be reduced to one for every 1,500 lineal feet if so directed by the Testing Engineer or Division Engineer.

As long, however, as there is any question about any factor effecting the quality of the concrete the two specimens should be sent to the Laboratory as given in these Instructions.

Directions for Making Sieve Analysis of Aggregates

(Field Method)

Briefly described, the apparatus for this test consists of an outside cylindrical container with telescopic cover, a nest of semi-cylindrical screens and sieves, a 10 inch rule and a 200 cc. graduated cylinder. The cylindrical container is exactly 10 inches in inside depth. As used at present there are in each outfit the following screens: ¾, 4 mesh,, 10 mesh, 20 mesh, and 50 mesh. In special cases other screens will also be used.

The large cylinder is used when making a screen analysis of a coarse aggregate while the 200 cc. glass cylinder is used in determining the gradation of sand or other fine aggregate.

Method for Testing Coarse Aggregate or Mixed Aggregates.

The cylinder is filled with the material to be examined, which is then screened through the screen or sieve selected. The portion retained on the screen is returned to the cylinder and the height of the material determined, each 1/10 inch corresponding to 1 per cent of the original volume. The portion passing the sieve is then screend through the next smaller sized screen and determined in the same manner. The total amounts as thus obtained always total over 100 per cent after screening. To reduce to the basis of 100 per cent divide each of the per cents by the sum total. For example, if a

run of bank gravel shows by measurement 15 per cent passing the screen and 95 per cent retained on the 4 mesh screen (total 110%) the correct values are $15 \div 110 = 13.6\%$ and $95 \div 110 = 86.4\%$.

Method for Testing Fine Aggregates.

In making a sieve analysis of a sand, fill the 200 cc. glass cylinder with the material. If the sand contains an appreciable per cent of coarse material retained on a $\frac{1}{4}''$ screen, first screen through the No. 4 sieve. Pour the material retained on the sieve back in the 200 cc. cylinder and read directly the number of cubic centimeters. The material is then screened through the successive screens, No. 10, No. 20, and No. 50 in order. Determine the amounts retained on each of the screens and the per cent passing the No. 50 sieve as outlined above. After screening, this will total over 200 cc. To obtain the corrected per cents, divide through by the total as described under coarse aggregates:

Example:

	C.C.	*%*
Retained on 4-mesh	20	9.3%
Passing 4-mesh and retained on 10-mesh	60	27.9%
Passing 10-mesh and retained on 20-mesh	50	23.3%
Passing 20-mesh and retained on 50-mesh	40	18.6%
Passing 50-mesh	45	20.9%
Total	215	100.0%

Proposed Field Determination of Clay and Silt

The apparatus used in this test is the same as that described under the method of making sieve analysis of aggregates. Two hundred c.c. of the sand or other fine aggregate are measured in the graduated cylinder and transferred to a one quart glass fruit jar with lid. Water is added and the sand washed by agitation. The large mineral particles are allowed to settle and the water containing the clay and silt

is poured into the large cylindrical container. The operation of washing with new portions of fresh water is repeated until the wash water remains clear. The water in the large container is allowed to stand over night to permit the clay and silt to settle out. The clear supernatant water is then poured off and the sediment of clay and silt remaining is transferred to the 200 c.c. graduated cylinder. Water is added to bring the contents of the graduated cylinder to 200 c.c. The volume of sediment in the cylinder is determined at the end of three hours. This volume divided by 2 gives the percentage by volume of clay and silt on a wet basis, three hours standing. This value is usually from 2 to 4 times the value obtained when determining the clay and silt by dry weight. If we assume, therefore, that the specifications require not more than 3 per cent of clay and silt by dry weight, less than 6 per cent by volume of clay and silt would indicate that the fine aggregate complies with the specifications while more than 12 per cent by volume of clay and silt would indicate an excess of material removed in washing. Between 6 and 12 per cent would indicate that sample was doubtful and that sample should be sent to Laboratory for official test.

Field Colorimetric Test for Organic Impurities in Sands

Equipment.

12 oz. graduated bottle.

Vials containing 5 grams of Sodium Hydroxide (Caustic Soda).

1 Aluminum Beaker.

Preparation.

Fill the bottle with water to the 6 oz. graduation, then pour into beaker, and add the stick of caustic from one of the vials and stir until dissolved.

Method.

Fill the bottle to the 4½ oz. mark with the sand to be tested, add the solution of sodium hydroxide until the volume of the sand and solution, after shaking, amounts to 7 oz. Shake thoroughly, and allow to stand over night. Observe the color of the clear liquid above the sand.

Interpretation.

If the liquid is colorless, or has a light yellow color, the sand may be considered satisfactory insofar as organic impurities are concerned. On the other hand, if a dark colored solution from dark red to black is obtained, the sand should be considered of doubtful character, and its use forbidden pending results of the usual strength tests in the Laboratory.

INSTRUCTIONS TO PLANT INSPECTORS AT PAVING BRICK PLANTS

The duties of the inspector include the following:

A. Inspection of the Rattler and Abrasive charge.

B. Selection and testing of samples from the cars or kilns.

C. Supervision of the loading of cars.

D. Submitting reports covering the work done and shipments made.

A. **Inspection of the Rattler.** Upon the arrival at the plant the inspector will go over the rattler as to form and dimensions, condition of the stave liners, condition and weight of the shot and speed of the machine. Any defects found should be reported at once to the person in charge of the plant with the idea of correcting the conditions found. The inspector must satisfy himself of the accuracy of the revolution counter by timing it occasionally to guard against possible defects in the equipment.

A brief description of the Rattler and Rattler Test as adopted by the American Society for Testing Materials in 1916 is given in the Appendix of Material Specifications No. 7.

B. **Selection and Testing of Samples.** In general, a single sample will be taken to represent each 10,000 to 15,000 brick according to conditions described later.

In the selection of samples the main object is to include in the proper proportions brick representing the different degrees of burning, shades of color, character of material used, and any other factors effecting the wearing quality of the brick. No brick are to be included in the sample which are cracked or so deformed as to be unfit for laying under the Specifications.

Before being placed in the rattler, brick selected for testing are to be carefully measured. Measurements for length, breadth, and depth, are to be made exclusive of lugs, bulges, or grooves, and such dimensions should fall within the limits stated in the paragraph of the specifications regulating "Size."

The size of brick, obtained by averaging the results of a number of determinations, is to be entered as indicated on the plant record.

The inspector will make a visual examination of the brick to determine the form, uniformity, freedom from kiln marks, cracks and checks in accordance with specification requirements defining "Quality" and all brick which are clearly unfit for laying must be culled, or the entire lot rejected if the condition is general.

Samples from Kilns. When samples are taken directly from the kiln, the first set will usually be chosen as soon as enough brick have been removed from the front of the kiln to permit of obtaining a sample representative of both the full width and height of the kiln. Later samples are to be taken with the idea of representing three (3) degrees of burning in the kiln, one (1) sample to be selected from localities (usually the top and sides) to represent the hardest burned brick, one sample usually selected from the more central portion of any cross section of the kiln to represent medium burned brick and one sample usually from the bottom layers and away from the sides to represent the least burned brick. Each of these samples should represent approximately 15,000 brick.

The results of the tests on a sample such as first described should determine the general average abrasion loss and acceptability of the brick according to the specified maximum loss. The results of the tests on the sets of three (3) samples will show the average abrasion loss of the brick represented and also the uniformity of the brick in the kiln. If the average of the tests in a set of three (3) falls below

the average specified loss and the difference in loss between the highest and lowest testing set is not beyond the permissible range, all bricks represented by the tests should be accepted. If, however, any one of the three sets should distinctly fail to meet specification requirements for maximum loss and if the brick represented by the remaining two sets would meet requirements both as to average, and variation in abrasion loss, then the latter are acceptable provided the manufacturer is willing to cull the unsuitable brick.

In any case where the rattler loss exceeds the specified amount solely as a result of extreme wear on one broken or defective brick, this result need not be considered and a retest should usually be run.

In any case of doubt, a retest sample should be taken and run to represent any lot of bricks which have failed on the first test, and if the average of the first test and the retest meet the specification requirement, the brick may be accepted.

Samples Taken from Piles. When the appearance of the pile of bricks shows clearly that there is a considerable range in the degree of burning, samples to represent each of the three degrees should be selected as in the case of samples taken from kilns, each sample in general to represent approximately 10,000 brick and the acceptability of all or parts of the piles will be determined in the same way as described under "Samples From Kilns."

When the surface appearance of the brick does not furnish any indication of their uniformity a sample should be taken at random representing approximately 10,00 brick. If this sample tests well below the average loss specified the one test for each lot of 10,000 brick may suffice. However, if the loss approximates the average loss specified or is between the average and the maximum loss allowed additional tests should be made. If the average loss of the tests thus made is below the average loss specified and none of the tests exceeds the maximum loss permitted then the brick may be accepted.

If the brick should fail to meet either one or both o these conditions the brick are to be rejected.

Samples from Cars. In special cases it may be necessary to take samples of paving brick from cars after they are loaded. In this event the following instructions will apply.

In general, follow the same directions as given under "Samples from Piles." Samples are to be taken from as many different points as possible corresponding to the length, breadth, and depth of the cars. In no case are they to be confined to the upper or outer layers. If the brick appear uniform in color and quality one sample may be sufficient. If there are various grades of brick present it may be necessary to take two or possibly three samples in which case the brick to be acceptable must show an average loss not to exceed the average specified and none of the samples must exceed the maximum loss specified.

C. **Supervision of the Loading of Cars.** The inspector is to supervise in a general way the loading of cars in order to determine that the brick loaded are those represented by his tests and that the culling is such as to exclude all cracked, chipped or deformed brick not permitted by the specifications as well as all brick from the kilns or piles which may have been found unacceptable.

D. **Reports.** The inspector is to submit at the end of each week to the Engineer of Tests, copies of all reports on samples tested. Tests are to be numbered serially beginning with No. 1 for the first test at a given plant in a given year. The inspector is also required to submit a weekly report on the proper blank form giving a complete record of the shipments made during the week.

The inspector is to send a postal card notice each day to the Resident Engineers of the counties to which the brick are shipped, giving the car numbers o fall cars of acceptable brick shipped from the plant on that day.

At the end of each month the inspector is to submit to the Engineer of Tests a Monthly Report on the proper blank form, giving a summary of the total number of brick shipped to each job during the month. This report is to show also the actual number of days employed on the inspection and the amount of the inspection charges allowed by the State.

INSTRUCTIONS TO PLANT INSPECTORS AT ASPHALT PAVING PLANTS

The inspector's duties include the following:

(1) To test or examine all materials used in the mixture.

(2) To determine whether the proper percentage or weight of each material is used. This includes checking the accuracy and capacity of the various scales and measures used in the plant producing the finished mixtures.

(3) To oversee the process of combination in order to see that the temperatures of the ingredients and mixtures are within the limits specified, and that the method of proportioning and combining the materials are accurate and thorough.

(4) To secure representative samples of the completed mixtures and of the individual materials as directed.

(5) To furnish on a daily report, information concerning the location of the contract, name of contractor, the kind or brand of materials used, tests made, proportions used, quantities of mixtures turned out, samples taken, and all general information relative to the operation of the plant as required by the daily report blank, and any special instructions that may be given.

A. **Inspection of Materials Delivered.**

1. **General.** Samples of each material used in the mixture will be submitted to the Laboratory at the beginning of work on each contract. Should source of supply of any material received change from that represented by the original sample, new samples should be submitted. Samples of all materials rejected by the inspector must be forwarded to the Laboratory.

Sands as Received. Samples of sand will generally be taken from each carload that comes into the plant. If it has been determined that the sand being supplied is of a uniform grade, one sample may be taken to represent as many as three carloads, but the inspector must combine material from each of the several cars in making up this sample. In all cases great care must be taken to see that the sample is representative of material delivered.

Unless otherwise directed, the sieves used in the test shall be the Nos. 200, 80, 40, and 10, using either of the following two methods:

(1) Place the sample (not less than 100 grams) on the No. 200 sieve, shake until practically no more material passes, weigh the residue, and place it on the No. 80 sieve, and continue in the same manner successively with the No. 40 and No. 10, weighing the residue on the sieve in each case.

(2) Stack the sieves in order, placing the No. 10 on top, and No. 200 on bottom. Pour the sample on the No. 10 sieve and shake for a period of ten minutes, or until practically no more material passes. Screening should be finished by shaking each screen individually, adding the material that passes to the next finer sieve.

The screen analysis of the sand as received should be reported on the *reverse* side of the Daily Report Sheet, indicating whether the sample represents one car or more. Give car numbers and numbe of tons. Note whether the sand complies with the requirements of the specifications for Sand B. C., Sec. 2-9.

When two grades of sand are being received for use in combination, separate sieve tests should be made on shipments of each variety, and the resultant combinations calculated. The proportions in which the two kinds of sand are combined should be shown on the report.

2. **Stone or Screenings.** The methods of selecting samples are the same as described under sand. The size of the dried sample used for testing should be not less than

250 grams for fine stone, and if the screenings are very coarse, an amount up to 500 grams may be used.

Samples of stone for bituminous concrete should be screened through the following screens or sieves: $\frac{3}{4}''$, $\frac{1}{2}''$, $\frac{1}{4}''$, 10-mesh. If there is an apreciable per cent of fine material passing the 10-mesh sieve the sample should be screened through the other sieves as used for the sand.

Shipments of stone are also to be examined for quality, freedom from dirt, and all foreign material.

Coarse stone to be used in binder coarse or Warrenite should be screened though the following screens: $1\frac{1}{2}''$, $1''$, $\frac{3}{4}''$, $\frac{1}{2}''$, $\frac{1}{4}''$. A sample of not less than 2,000 grams should be used. With coarse stone particular attention should be given to secure a *representative* sample of the stone delivered.

3. **Stone Dust or Portland Cement (For Filler).**

At the beginning of the work a representative sample of the dust or filler should be selected and the percentage of material passing a No. 200-mesh sieve determined.

4. **Sampling Refined Asphalt and Asphalt Cement.**

When refined asphalt is shipped to the plant in drums or barrels, the inspector is to obtain a sample from each shipment selected from at least three barrels, and from a point not less than three inches below the surface, which will be melted together, and the penetration determined. Such samples must be melted with a great deal of care to avoid local over-heating, but at the same time a temperature of at least 300 to 325°F. must be reached.

The inspector will also note and record the brand name marked on the barrel or drum, and penetration, when given.

5. **Testing Asphaltic Cement.**

The inspector will take, as far in advance of use as possible, a sample of each tank car of asphaltic cement (in case it is shipped this way) and of each tank or still of asphaltic cement, and determine the penetration at 77°F.

In making the penetration test the following rules are to be observed:

(a) The sample is never to be cooled in ice water or in air colder than 60°F.

(b) The sample must stand in air for not less than 30 minutes and in water at 77°F. for not less than 1 hour. If quick results are required, the time in water may be reduced to 45 minutes, and the penetration thus obtained checked after the full hour has elapsed. A container of at least 2-gallon capacity should be used as a water bath.

(c) All the penetration tests must be made with the sample under water unless the air temperature happens to be 77°F.

(d) Keep the needle clean, but never use oily waste or cloth in cleaning it.

(e) If a small sample of asphaltic cement has stood in air for more than 3 or 4 hours, it should always be heated carefully and gradually to a temperature of about 325°F., the top skimmed off if possible, and the balance stirred thoroughly before being tested.

(f) The penetration will be set for each contract. A working range of four points either above or below this penetration will be allowed. For example, if the penetration is set at 50 the range will be from 46 to 54. If at any time the results obtained at the plant should show a deviation above the maximum or below the minimum, a check determination should be made. If on check tests the sample shows a greater deviation than that permitted, the use of the material must be stopped and the Laboratory communicated with for advice.

B. **Inspection of Proportions:**

The inspector will receive instructions in regard to the desired proportions of each ingredient that enters into the mixture. He must then make all necessary determinations of the accuracy of scales, and see that the required percentages or proportions are actually being used.

Having made preliminary sieve analysis on the aggregates as delivered, and having determined the most satisfactory batch weights to be used, the inspector shall make screen tests on the aggregates after they have passed through the dryer and screens. The most important tests are those made on the materials as they are to be incorporated in the work. The samples should be secured by passing a shovel or pan through the stream of hot sand and stone as same runs to the storage bins or from the storage bins to the mixer. Particular attention must be given to the securing of *representative* samples, since it is from these samples that the inspector must determine whether the bituminous concrete being produced complies with the grading requirements of the specifications. The sieve analysis obtained on these samples are reported on the Daily Report Sheet under "Mechanical Analysis (Per cents). The sand portion, after cooling sufficiently to handle, is screened through the sieves as described under "Sand as received". If an appreciable per cent of sand is retained on the ¼" screen the coarser screens should be used as required.

The stone portion obtained from the stone storage bin as described should be screened through the same screens as described under "Stone and Screenings".

The results of these tests will show:

(a) When blended sands are being used, the results from the sieve analysis of the sand will show whether mixing is being carried on satisfactorily.

(b) Whether separation of sand and coarse aggregate by screening has been complete.

(c) Whether the amount of 200-mesh material originally in the sand has been increased or decreased in the drying and screening processes.

If the dried sand is contaminated with stone or if sand is being carried over into the stone bin, steps should be taken at once to ascertain the cause and correction made to the screen if necessary.

If the screen analysis of the materials as they are used in the mixture run reasonably uniform throughout the day, it will only be necessary to show on the Daily Report Sheet the determinations for one period. It will be well, however, to make at least two complete tests during the day, one in the forenoon and one in the afternoon. If the materials are not running uniform more frequent tests should be made.

To determine the amount of bitumen obtained from a given amount of asphaltic cement use the following figures: Refined residual or oil asphalts (Mexican, California, Texas, etc.), 100% bitumen, refined Bermudez, 95% bitumen, refined Trinidad, 56% bitumen. Fluxed Trinidad (asphalt cement) will contain a greater percentage of bitumen than that stated, depending upon the amount of fluxing oil used. The oil is to be considered 100% bitumen and the inspector will compute the percentage of bitumen in the asphaltic cement, knowing the number of pounds or proportions or refined asphalt and flux used. When Trinidad asphaltic cement is purchased, fluxed to the proper consistency for use, the percentage of bitumen will be secured from the Laboratory.

Computation of the Grading of the Bituminous Concrete.

The determination of the per cent of each size of aggregate in the finished mixture is to be made and reported as indicated on the Daily Report Sheet. This is done as follows: multiply the batch weight of the sand by the percentage weight of each size. For example, supposing 600 pounds of sand are being used in each batch and that the sand has 20% between No. 10 and No. 40 sieves. Then $600 \times .20 = 120$ pounds of 10-40 size in the total batch furnished by the sand. The weights of each size contributed by the other materials is computed in the same way.

The total weights of each size is then determined by adding the amounts contributed by each material. For example, supposing that in the case referred to above that the stone portion also contained four (4) per cent of No. 10-

40 size, and that the batch weight of stone being used was 200, then $200 \times .04 = 8$ pounds of this size contributed by the stone or a total of 128 pounds in the batch.

To arrive at the percentage of 200-mesh material in a mixture, first determine which of the ingredients contain particles of this size. Stone dust or cement, sand, screenings, and Trinidad asphaltic cement may all contribute to the total. Determine the percentage contained in each of these materials and the proportions of each material used in the mixture, from which can be figured the percentage of 200-mesh material—based on the total mixture, contributed by each ingredient.

To determine the percentage of each size of material it is only necessary to divide each of the total weights by the total batch weight. If the total batch weight is 1,000 pounds it is only necessary to point off one decimal point, thus giving percentage direct.

C. **Inspection of Process of Combination.**

The inspector is to take temperatures of the ingredients (especially the mineral aggregate) and of the mixtures as frequently as possible and is to assist the plant employes in every way in keeping the temperatures uniform by notifying them of any marked changes that he may observe.

Should the aggregate be of improper temperature in the weighing box, the inspector should endeavor to prevent the incorporation of A. C. and in this way avoid the unnecessary loss of the batch of completed mixture. The desired temperatures at the plant will depend upon the kind of mixture being prepared, the kind of asphalt being used, the weather conditions, and the length of haul. The best temperature for raking on the work will be not less than 275°F. for sheet asphalt, and other fine graded mixtures. Mixtures which contain a high amount of filler, or are prepared with Trinidad asphalt, will require slightly higher temperatures for proper raking. Mixtures which are made up chiefly of stone should range between approximate temperatures of

225°F. and 325°F. in order to preserve a proper coating of asphalt on the surface of the stone. The inspector will be instructed as to the temperature range fixed for each contract, which will be governed by conditions peculiar to this contract. In no case is any mixture to be allowed to leave the plant which is at a temperature higher than 375°F. at the time of dropping from the mixer. Overheated aggregate may be cooled in the mixer before adding the asphalt, but material cooled in the mixer to a point below 375°F., after the asphalt has been added, will not be acceptable. The lowest acceptable temperature on the work will be about 225°F. for mixtures containing a high percentage of stone, or about 250°F. for sheet asphalt wearing surface. It is to be understood, however, that these temperatures are not recommended, and that only occasional batches will be accepted.

The inspector is to note on the mixing platform whether the scales are being handled carefully, taking care that the bucket swings free during weighing, and that the beam is brought to a floating position and the bucket drained completely for each batch. He will also check, or have the mixer man check, the tare weight of the empty asphalt bucket at *frequent intervals,* so as to take care of any increase or decrease in the amount of asphalt clinging to the bucket after each pouring. Particular attention must be paid to this point in cool weather, and, in general, at times when there is a long interval between loads.

The inspector is to make certain that the mixer man allows the mineral aggregates to become thoroughly mixed before the addition of the asphaltic cement.

D. **Sampling Materials and Mixtures.**

Unless otherwise ordered, a daily sample is to be taken for Laboratory test of each tank or still of asphaltic cement used in the day's work. The samples are to be placed in the 3-oz. round tin boes, the boxes carefully cleaned and the lids closed tightly. The inspector is to make his penetration

tests on the same samples as sent to the Testing Laboratory, taking care to drain all water from the needle holes after testing.

Unless otherwise directed, a daily sample of the asphalt wearing surface or bituminous concrete, as the case may be, is to be taken in a small quantity at a time, from not less than ten and preferably more separate batches, molding the portions into a compressed block. The final sample of asphalt wearing surface should weigh from one-half to one pound, and that of bituminous concrete not less than two pounds.

In selecting the portions of the sample care should be taken to scrape away the top material in the load, so as to avoid dust or unrepresentative material.

At the beginning of work on each contract, and whenever thereafter, the character of materials used in the work is changed the inspector shall submit samples of the following quantities to the Testing Laboratory:

One pint of refined asphalt or A. C.

One pint of flux.

Five pounds asphalt sand.

Fifteen to twenty pounds of crushed stone.

At the beginning of operations on a given contract the samples of each grade of material taken should be numbered serially, starting at number one and continuing until the completion of the work, using the same serial number for both A. C. sample and the bituminous concrete sample for any given date. If two samples of A. C. should be sent for one day's work with one sample of bituminous concrete, mark the samples "A" and "B", but use the same serial number for each as used for the bituminous concrete. In other words, a given serial number should represent the materials used on any particular day. These numbers are to be scratched or punched clearly on tin cans, and marked with red pencil on the surface of bituminous concrete or similar

samples. Samples are to be shipped immediately to the Testing Laboratory by Parcel Post.

E. **Daily Reports.** The inspector shall fill out and mail daily reports on the regular printed form, giving all the required information. Reports should be in ink.

INSTRUCTIONS TO ROAD INSPECTORS

on

BITUMINOUS CONCRETE WORK

Preparation of Base for Laying Bituminous Surfaces. All foreign material such as mud, dust, or standing water must be removed from the base course before the arrival of surface mixtures. There is no objection, however, to the laying of hot material on damp concrete still retaining moisture from a rain during the previous night. Any portion of mortar or aggregat projecting above the fixed grade of the base, especially along curbing, must be removed by means of picks.

At low points in grade where water will accumulate in quantity on the base, drainage is to be provided during construction of base course. In case this detail has been neglected the inspector will cause openings of about 1″ in diameter to be drilled diagonally through the base at the junction with header curbing. A stone drain should be constructed from the outlet of this opening to the tile drain or opening to the tile drain or open ditch.

Care should be exercised in the painting of curbings, manholes, boxes, joints, etc. The specifications must be followed to the letter, i. e., the surface to be painted must be dry and free from dust and the paint applied in a thin uniform coating, the material and methods being given below under (a) and (b).

(a) Asphaltic Cement. When hot asphaltic cement is used as a painting material, it should be heated until thoroughly liquid, but not above 325°F. Melting the asphaltic cement by use of hot tampers will not be permitted. Much

trouble has been experienced in the past from overheated or underheated asphaltic cement.

(b) Asphalt Cut-back with Naphtha. Asphalt cut-back with naphtha should be prepared at the refinery, but may be prepared at the plant or on the work by adding and thoroughly mixing from 25 to 30% of motor gasoline to asphaltic cement which has been heated until it is of liquid consistency. Great care must be taken in the preparation and use of this material as it is very inflammable. Should the naphtha cut-back become too thick for application it may be thinned by the addition of more motor gasoline. A heavy paint brush may be used to advantage in applying this material.

The asphaltic cut-back with naphtha is considered a superior material to asphaltic cement because of greater ease of application and also because the latter material is too often damaged by successive heating and overheating.

Delivery of Materials. Should a load or a portion of a load of material become stiffened during transit to such an extent that it will form in hard lumps and not permit uniform distribution by raking, the material must be rejected and thrown out. The appearance of free asphalt on the surface of a load of binder or bituminous concrete, especially after a long haul, is not necessarily an indication that the mixture is too rich in bitumen. All mixtures containing stone are very likely to show this condition. Lumps of very rich material from the surface of the load should, however, be thrown out as it is extremely important to avoid an excess of bitumen. Too rich a mixture will almost invariably result in a soft pavement which will become "wavy" in warm weather. In general, special care should be used with loads that appear to run irregular as to temperature, mixture, or otherwise. Material shall not be delivered when it is found impossible to receive its initial rolling in daylight. Canvas covers must be provided by the contractor for delivering vehicles so that the delivery heat requirements of the specifications can be met.

The inspector will be provided with an armored thermometer for the purpose of determining temperatures of the mateial being received. He must exercise care in the use of this instrument against breakage. He will take the temperature of a sufficient number of loads to satisfy himself that the material being received is of uniform temperature, and within the limits set by the specifications. He will record the readings in his note book and be prepared to furnish when required the average temperature of each day's run. He must bear in mind that his instrument is expensive and extremely fragile and he must exercise care in its use against breakage.

Unloading of Materials. Asphalt Wearing Surface, Binder, or Bituminous Concrete should be dumped in piles outside of the area on which it is to be spread, beginning at a distance of about six to eight feet back of the previously raked material. From this point the load should be distributed over a length corresponding to the distance which a single load will cover, but in no case will the material be spread along from the truck.

The mixture must be thrown forward into place, always cleaning up the bottom of each pile. The inspector should calculate the distance to be covered by each load, and use this in connection with the unloading of the trucks and in determining that the mixutre is spread to the proper average depth.

Samples. When so instructed, the inspector will lift samples of sheet asphalt or bituminous concrete. The method of sampling will be in accordance with that described under "D" Sampling Materials and Mixtures in the "Instructions to Plant Inspectors at Asphalt Paving Plants."

Spreading Binder Mixtures. Careless spreading and raking of this course should be guarded against. Raking must be thorough and the material distributed uniformly, avoiding segregation of stone or bituminous mortar. De-

pressions and other defects in the base must be corrected with this course. If a considerable portion of the base shows defective construction, the contractor will be required to furnish a template cut to the cross section of the finished pavement which will be used as a guide in the laying of the binder course or bituminous concrete.

Spreading Surface Mixtures. The inspector must supervise dumping of loads of material. Spreading from trucks will not be permitted. The hot material must be placed in piles far enough ahead of rakers to necessitate moving the entire load, and space enough provided for the rakers to stand on the base and not on the hot material. In casting material from piles to rakers the shovels must be turned, thus permitting the compressed material taken from the bottom of the pile to be broken up by the rakers. Rakers will not be allowed to tramp over or stand in the hot material except in case of extreme dense, stiff bituminous concrete mixtures, the rakers will be permitted to push the material ahead of the rakes, rather than pull it. This will, of course, necessitate their standing in the raked material. However, this is not regarded as harmful in this type of mixture, but in raking sheet asphalt, the rakers will not be permitted to stand in the hot material.

During the process of raking all the material must be thoroughly loosened and evenly distributed by the rakes, and any material that is lumpy and does not break down easily must be wasted, for if left in the pavement, uneven compression will result. Rakes must have tines of sufficient length to penetrate the full depth of the loose mixture.

After the raking has been completed and before rolling is started, the inspector should sight along the surface to make sure that the material is raked to the proper cross section and grade. Do not rely upon the rakers to be perfect in this respect. Much better results can be obtained by correcting humps and depressions before rolling is started than after initial compression has taken place.

The depth of the loose material should be checked frequently, making proper allowance (usually from 25% to 33⅓%) for compression. It frequently happens that the depth of loose raked material will decrease so gradually from the required amount that the rakers themselves are not aware of the fact. Ordinarily 2½ inches to 2⅝ inches of loose material is required to give 2 inches of compressed material, but the inspector should make determination on this point for each particular mixture.

Compression of the Surface. Tamping. Adjacent to curbing, etc., compression will be effected by means of hot tamping irons as directed by the specifications. A perfectly sealed joint with the curbing, is absolutely essential in the water proofing of the pavement and unless the entire surface of the pavement is waterproof, disintegration may soon take place. In the laying of mixed seal coat as well as other surface mixtures, hot tampers should be used along the header curbing to produce a sealed joint that will prevent water from entering between the curb and the asphalt pavement. In cases where the high curb is used and the grade is low, gutters should be tested with running water so as to insure sufficient grade for drainage to the desired outlet. Tampers should follow directly after the rakers, first forming the joint, then progressing along curbs and structures. The use of overheated irons must be avoided. The surface of header curb, railway track liners, etc., should be thoroughly cleaned of all loose material before rolling of the wearing surface begins.

The Roller. — When possible the roller should be weighed in order to determine whether it meets with the specification requirements. The roller wheels should be tested with a straight edge in order to detect untrue surfaces. Badly worn bearings should be replaced before the roller is used. The use of a defective roller will cause a wavy and untrue surface. During the first rolling the roller wheels must be kept moist in order to avoid the picking up of the material. This

does not mean that the roller man is to be permitted to keep a constant stream of water playing on the wheels which will unnecessarily chill the surface of the pavement. Excessive use of water is to be especially guarded against in cold weather. The inspector should take note that the holes in the spray pipes on the roller are not too large.

A mixture of kerosene or light fuel oil, and water may be used for moistening roller wheels, being somewhat advantageous for cold weather work, in that the roller wheels are kept warm, thus closing up the surface of the pavement more rapidly. The use of an oil for this purpose must be accomplished with care, avoiding spilling of the oil on the pavement or the dragging of the mop, by which it is applied, across the pavement. On bituminous concrete mixtures the oil sometimes flushes free A. C. to the surface, producing spots to which the seal coat will not adhere. If this condition occurs the use of oil must be discontinued.

Method of Rolling. It is important in the following process that the roller moves at a slow but uniform speed and that the direction of rolling is not suddenly reversed, as this will displace the bituminous mixture. There is no definite rule covering the time after spreading when the rolling should begin. In coud weather it must, of course, be started promptly, but in hot weather it may be necessary to delay rolling for a short time in order to allow the material to cool, so as to avoid excessive displacement and picking up on the roller wheels. In rolling sheet asphalt, if the surface of the mixture is too hot, water from the roller will usually cause it to blister and adhere to the wheels. When this condition arises, rolling should be delayed for a time, the roller wheels cleaned off, and the blistered spots raked out and brought to grade with fresh loose material.

In case the roller should cause a displacement of the wearing surface, such spots should be loosened at once with rakes and restored to the original grade of the loose material before being rerolled. This condition will frequently be

noted at the point where the roller is reversed, that is, at the junction of the rolled and unrolled material. By sighting over the surface, it may be found that the loose material just ahead of the roller has been displaced and its depth correspondingly increased, and a low spot produced in front of the line where the roller stopped.

Do not allow the roller, or any vehicle such as a heavy water wagon or truck to stand on the finished pavement until it has thoroughly cooled after the final rolling. The roller engineer should never be permitted to draw his fire on the finished pavement.

If at any time the roller is temporarily incapacitated, due to lack of steam, or water, or for other reasons, the dumping and spreading of material must be discontinued until it is again in operation.

Correcting Defects in the Surface. Before starting operations the roller must be inspected for weight and balance and throughout the work it shall frequently be examined for parts that might be out of balance, thus causing variations in the surface. As far as possible avoid too much patching after the mixture has once been rolled, and make it a point to catch all irregularities and honey-combed spots while the material is still soft. So called "skin patching" will not be permitted. Patches to pavement that has become thoroughly chilled will involve the complete removal of the wearing surface in area effected. In any case patches must be placed against a granular surface. A 10-foot straight edge for testing the finished pavement is required in the specifications, and must be kept on the work at all times. When the straight edge is placed longitudinally with the roadway, depressions in excess of $\frac{1}{4}$ inch in 3 feet or $\frac{3}{8}$ inch in 10 feet are an indication that proper workmanship is not being obtained.

During cool weather, or in the use of a load containing some cool material which does not rake freely, the surface

of the pavement is apt to be honey-combed after rolling. If these voids are large enough to warrant, have some fine material raked over the surface and roll immediately, but avoid as far as possible the use of smoothing irons and never permit the use of any which are at a red heat. When the use of the smoothing iron is required, all work done with it should be completed before the pavement has cooled and set, as at that time sealing may be accomplished without so great danger of coking the material. Slightly porous spots in bituminous pavements will usually iron out under traffic during war weather, if the porous condition is simply on the surface of the pavement. In cold weather construction it will be necessary to use extraordinary means of sealing honey-combed or porous surfaces. Any such defects that remain after final compression must be sealed by hot asphaltic cement, spread by tamping irons and covered with dry sand which is ironed into the open surfaces. Always after final rolling the inspector should examine joints with curbing, track liners, etc., to see that these joints are perfectly sealed. Any cracks that remain must be sealed with naphtha cut-back or hot asphaltic cement.

Joints. During the progress of a single day's work the number of joints should be as few as possible. When working during warm weather, and as long as the mixture is being received at a steady rate, the roller should not be permitted to roll over the end of the raked material, but in case there is a delay between loads and the roller does cross the joint, rakes should at once be used to loosen the mixture and give a bond for the new material. Fresh mixture should never be laid against a sealed surface over which the roller has passed. Joints at the end of the day's work must be cut in such a manner as to give a complete and satisfactory bond. In bituminous concrete mixtures, the joint must be cut square, and to the full specified depth of the pavement, painted with a very thin, uniform coat of A. C. and the new mixture placed against it, tamped by hand, and

sealed with a tamping iron before the roller goes over the joint.

With sheet asphalt wearing surface a properly made lap joint will be acceptable, but in every case, the surface which has been sealed up by the roller must be cut away, so as to expose the fresh grain of the mixture, and there must be a vertical cut of three-quarters of the depth of the wearing surface. The rope joint will be found very satisfactory. The rope should be not less than 1 inch in diameter and should be placed across the road about six inches back of the joint. When the rolling is completed the wearing surface is to be cut away with a pick, back to the depressions left by the rope. Painting and the placing of fresh material is to be done as above described.

Interruptions in Work Due to Rain. Mixing at the asphalt plant is required to cease when rain sets in, but material which is enroute from the plant may be laid if the rain is very light; or it should be held on the work in trucks or wagons until the rain has stopped, after which it may be laid, providing proper care is used to remove puddles of water. If a heavy driving rain sets in and continues, materials which was enroute from the plant at the time must be wasted. In no case is mixed seal coat to be laid while rain is falling, since a thin layer of this character will be chilled very rapidly by the water and fail to give a uniform coating over the pavement.

Use of Hot Mixed Seal Coat. During the laying of bituminous concrete requiring a mixed seal coat, this material properly protected against rapid loss of heat must be kept on the work continuously. Trucks containing the bituminous concrete will not be dumped until the inspector is satisfied that there is sufficient seal coat on the work to cover the bituminous concrete. Placing of the seal coat should begin after the roller has completed initial rolling of about 75 lineal feet of road, i. e., on a sufficient length to

give a proper sweep for the movement of the roller. After this, the placing of the seal coat should be practically a continuous operation following after the initial rolling. This mixture, however, should not be placed until the roller has taken out all of the creases from the bottom course mixture, and it should not be brought up too close to the unrolled material.

Laying on Broken Stone Base Course. When a bituminous pavement is laid on a broken stone base course which has received a surface treatment, any liquid bituminous material which accumulates in depressions or at the edges of the road must be broomed out carefully and the treatment must have dried out completely before laying is started. Areas in which the stone is poorly consolidated must be properly compressed before the wearing surface is laid. Also any cold patches in the base course in which there is an excessive amount of bituminous material must be removed and replaced with binder or bituminous concrete. Free screenings coated with bituminous material, matted on base, must be removed before surface mixture is laid. When an edging is not provided, the surface course must be laid against wooden edging strips of the depth of the pavement, firmly staked and set true to line and grade. Strips that are warped or have become worn by use must be thrown out. Mats of excess screenings and oil must be removed prior to laying of bituminous surface course.

Co-operation with the Plant Inspector. The road inspector should keep in touch with the plant inspector and report as accurately as possible any unusual or unsatisfactory conditions noted in the laying and rolling, i. e., mixture which is too cold, too rich, not uniform, too close, too open, or any similar condition, also any error in the rate of dispatching of seal coat or other mixtures. This is a matter that should, of course, be left largely to the contractor. The plant inspector is not responsible for delays in transit which cause

loads of material to cool and become too stiff for free raking. The road inspector must not fail to communicate to the plant inspector at the end of each day, the location by stations of the pavement laid that day, advising him of any variations from the usual width and depth of pavement that may have occurred, also of the amount of material rejected on the road, and amount of labor employed. The plant inspector must make frequent checks on the number of boxes in different loads and keep the road inspector informed.

INSTRUCTIONS TO INSPECTORS

Bridges and Culverts

Do not attempt to inspect the construction of Bridges and Culverts until you have a set of the plans and specifications which you have studied carefully.

Examine all bridge and culvert material as soon as possible after it is delivered on the job, and report to the Resident Engineer regarding any materials which should be rejected.

Do not allow the contractor to start construction until line and grade stakes have been set by the Resident Engineer.

Make sure that the forms are properly braced and wired or bolted so that they will not spread or bulge out of line when filled with concrete.

Forms should be practically water tight. Do not allow concrete to be poured when there are cracks in the forms where mortar can run out.

If the shoring sets on mud sills, see to it that wedges are placed so that any slight settlement can be taken up.

Do not allow the contractor to pour concrete against the unprotected sides of the excavation. FORMS are required in all cases.

When the excavation for piers or abutments is made to the depth called for on plans, notify the Resident Engineers and do not allow concrete to be poured until he has approved the foundation.

There are five things to look out for in placing reinforcing steel:

1st. That the bars are the right size and length.

2nd. That they are spaced as called for on the plans.

Riprap stone piled against the base of a bridge abutment to protect the foundation against scour.

3rd. That they are correctly located. Make sure where the drawing shows them to be. This should be checked carefully.

4th. All steel is to be wired in placed before pouring concrete. Don't let the work start with the idea that there will be plenty of time to place the steel while the concrete is being poured.

5th. For spans over six feet, do not pour concrete until the Resident Engineer has approved the reinforcing steel in place.

If it is nesessary to make construction joints in the concrete, their location must be approved by the Resident Engineer.

There are five things to watch for while pouring concrete:

1st. That the correct amount of aggregates, cement and water are used for each batch and that the time of mixing is as called for in specifications.

2nd. That the mortar is well slushed under and around the reinforcing steel in slabs, beams and girders.

3rd. That spading is well done, especially along surfaces which will be exposed.

4th. That the forms are clean and free from debris and that all wooden spacers are removed as the concrete is poured. That the concrete is placed in layers as nearly level as possible.

5th. That the forms and shoring do not start to bulge or settle.

If hand mixing of concrete is necessary it must be done on a water tight platform, not on the bare ground.

Do not allow the contractor to place concrete under water except by special permission fom the Resident Engineer.

Paint coats for surface finish of concrete are not permitted.